

Tunable-Bandwidth Filter System

Pass bands can be tuned rapidly across the visible and near infrared spectrum.

Stennis Space Center, Mississippi

A tunable-bandwidth filter system (TBFS), now undergoing development, is intended to be part of a remote-sensing multispectral imaging system that will operate in the visible and near infrared spectral region (wavelengths from 400 to 900 nm). Attributes of the TBFS include rapid tunability of the pass band over a wide wavelength range and high transmission efficiency. The TBFS is based on a unique integration of two pairs of broadband Raman reflection holographic filters with two rotating spherical lenses. In experiments, a prototype of the TBFS, was shown to be capable of spectral sampling of images in the visible range over a 200 nm spectral range with a spectral resolution of ≈ 30 nm.

The figure depicts the optical layout of a prototype of the TBFS as part of a laboratory multispectral imaging system for the spectral sampling of color test images in two orthogonal polarizations. Each pair of broadband Raman reflection holographic filters is mounted at an equatorial plane between two halves of a spherical lens. The two filters in each pair are characterized by steep spectral slopes (equivalently, narrow spectral edges), no ripple or side lobes in their pass bands, and a few nanometers of non-overlapping wavelength range between their pass bands. Each spherical lens and thus the filter pair within it is rotated in order to rapidly tune its pass band. The rotations are effected by electronically controlled, programmable, high-precision rotation stages. The rotations are coordinated by electronic circuits operating under overall supervision of a personal computer in order to obtain the desired variation of the overall pass bands with time.

Embedding the filters inside the spherical lenses increases the range of the hologram incidence angles, making it possible to continuously tune the pass and stop bands of the filters over a wider wavelength range. In addition, each spherical lens also serves as part of the imaging optics: The telephoto lens focuses incoming light to a field stop that is also a focal point of each spherical lens. A correcting lens in front of the field stop compensates for the spherical aberration of the spherical lenses. The front surface of each spherical lens collimates the light coming from the field stop. After the collimated light passes through the filter in the spherical lens, the rear surface of the lens focuses the light onto a charge-coupled-device image detector.

*This work was done by Tin Aye, Kevin Yu, Fedor Dimov, and Gajendra Savant of Physical Optics Corp. for Stennis Space Center. For further information, access the Technical Support Package (TSP) **free on-line at** www.techbriefs.com/tsp under the category.*

SSC-00210-1

A **Laboratory Prototype of the TBFS** contains two rotating spherical lenses containing broadband Raman reflection holographic filters. The pass band of each filter varies with the angle of incidence. Hence, the rotations are coordinated to obtain coordinated variations of the pass bands with time.

Comments and Questions to Center

1. The source documents provided to us are (a) pages 1, 2, and 4 of a NASA form 1679 and (b) pages 2, 4, 5, 6, and 7 of a document labeled "Final 0503.3581 NASA-TBFS II Contract No.: NAS13-01005."
2. To expedite things, we try to draft an article from available material if we feel that we can construct a coherent story. Often, we succeed and move forward. If the article as written is materially in error because of our lack of access to the missing pages, then please make the necessary corrections.
3. Dutifully using the innovators' nomenclature, we have called the innovation a tunable-**bandwidth** filter system, but this appellation strikes us as one of misplaced emphasis. The term "tunable-**bandwidth**" connotes an ability to tune the width of the pass band independently of the nominal or middle pass wavelength. As best we can determine from the information in the source documents, as a consequence of mounting a pair of filters inside a spherical lens, the bandwidth of the light emerging from the lens cannot be tuned independently of the nominal or middle frequency of the pass band. Instead, it seems to us that the bandwidth tuning is a relatively small effect incidental to the tuning of the middle or nominal wavelength of a narrow pass band.

In other words, it seems to us that the innovation should be characterized more ambiguously as a tunable-**pass-band** filter system so as not to give the impression that the nominal pass wavelength and the bandwidth can be adjusted independently of each other. If this reasoning is erroneous, then please explain or disregard our comments.

Thanks, T.S.

